ZOOLOGY.—*A new species of* Allogaussia (*Amphipoda, Lysianassidae) found living within the gastrovascular cavity of the sea-anemone* Anthopleura elegantissima.

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In the spring of 1955, while on a field trip to Moss Beach, San Mateo County, California, a group of zoology students from the University of California discovered that by squeezing individuals of the aggregating anemone *Anthopleura elegantissima* they were able to obtain from the gastrovascular tract small pinkish gammarid amphipods which were obviously alive and apparently uninjured by the nematocysts and digestive enzymes to which they were exposed. Howard Law, one of the discoverers, presented in a brief unpublished paper (Law, 1955) a preliminary description of the body and of various appendages, but he was unable to correlate with certainty the characters he found with those of any gammarid family. Nevertheless he tentatively placed it within the Lysianassidae on the grounds that it resembled this family more closely than it did any other. The present study is the result of an attempt to identify this unusual amphipod.

The amphipods described below were, for the most part, collected from anemones during the latter part of December 1955 and January 1956 and were stored in 70 percent alcohol. All came from the same location; namely, the "Sand Rocks" at Moss Beach. The location name is taken from the map of Moss Beach in Light et al. (1954).

METHODS AND MATERIALS

To assure that all spines and setae would be visible, the following method was employed in preparation of specimens for dissection. The specimens were first placed in a solution of 70 percent alcohol and fast green and left over night. They were then taken through a series of increasing alcohol concentrations (70-90-95-100 percent) to clove oil, in which they were allowed to clear and harden. The brittleness given to the specimens by the clove oil proved a great aid in dissections as the appendages could be separated from the body without tearing. The stained and dissected amphipods were mounted in clove oil under a cover glass and observed with a compound microscope. Approximately 30 individuals were treated in this way. The figures were drawn with the aid of a camera lucida.

DESCRIPTION OF THE GENUS

A review of the literature has revealed that there are no less than 110 genera in the Lysianassidae, the family to which the present species belongs. Of these, 48 are described in Stebbing's monograph (1906). The genus *Allogaussia* Schellenberg (1926) as modified by K. H. Barnard (1932) seems to include the present species with two further points of expansion necessitated by the inclusion of the amphipod described below. In the following translation of the original description of the genus by Schellenberg, Barnard's addenda are given in parentheses. Expanded characters applying only to the present species are included in the description.

Description.—Body broad. Coxae long. (Side-plate 4 may or may not fit into a groove on side-plate 5.) Third epimeral plate not produced to a tooth. Telson short and rounded or sinuous (or long and notched or shallowly or deeply cleft). Antennae of nearly equal length (stout in both sexes); second joint of peduncle of antenna I relatively long, (or very short compared with its breadth, with third joint easily visible dorsally, ventrally entirely masked on inner side by first joint of flagellum). (First flagellar joint stout and elongate, first joint of accessory flagellum also elongate.) Flagellum of antenna II in the male not long. Epistome arched forward over the upper lip, (with a narrow notch separating it from the upper lip). Cutting edge of the mandible simple with a subterminal "canine tooth." Molar of moderate size, channeled. Palp arising behind the molar; first joint short, second joint longer than the third. Inner lobe of maxilla I with two terminal setae. Inner lobe of maxilla II somewhat shorter and more slender than the outer lobe, both lobes slender. Maxillipeds well developed. Gnathopod I powerful, subchelate or slightly chelate as in the species described below (Fig. 3, J). Metacarpus longer than the carpus. Gnathopod II chelate. Peraeopods 5–7 short. Base of peraeopod 5 peculiarly broadened or not "peculiarly" broadened as in the present species (Fig. 3, R). Base of peraeopod 7 broad. Uropod II considerably surpasses the shorter ones; also, in the nonsetose uropod III of the male the inner ramus is shorter than the 2-jointed outer ramus, (or uropod III is slightly longer with setae on both rami). Near *Orchomenella*.

Since no type species has been assigned *Allogaussia*, I wish to designate *A. paradoxa* Schellenberg as such.

Schellenberg gives three species of *Allogaussia*; Barnard adds two others. Of the five named species, not one corresponds completely to the one discovered at Moss Beach; therefore, the following name and description are proposed for the new species.

DESCRIPTION OF **Allogaussia recondita**, n. sp.

Allogaussia recondita, n. sp. (Fig. 1). The specific name comes from the Latin, *reconditus* = hidden, and refers to the distinctive microhabitat in which this species is found.

Diagnosis.—*Allogaussia recondita* is distinguished from all previously described members of the genus by the following characters: The slightly chelate gnathopod I; the relatively weak broadening of the base of peraeopod 5; the shallow excavation in the posterior margin of the second joint of peraeopod 7; the produced apex of the typical female telson; the extremely deep emargination of the medial edge of the third joint of antenna I in the male; the distal accessory branchia on peraeopod 4; and by the combination of a setose uropod III (in the male) and the absence of a groove on side-plate 5 into which side-plate 4 fits. The association with *Authopleura elegantissima* is likewise unique.

Description.—Integument smooth. Body compact, broadly rounded dorsally in both sexes. Head with anterolateral angle acutely produced with the angle itself rounded. Eyes large and kidney-shaped with the concave margin anterior. Facets of eyes bright red in life, with interstices between facets white. Side-plates 1–3 long, 1 more rounded ventrally than 3; 4 (Fig. 3, M) longer and broader than the others, with a long rounded posterior excavation, the posterior projection broadly rounded, not fitting into a groove on side-plate 5 (Fig. 3, R). The base of peraeopod 5 (Fig. 3, R) expanded posteriorly, but not to the same exaggerated extent as in other species of *Allogaussia*. Side-plate 7 (Fig. 3, S) small, with rounded posterior margin longer than anterior margin and as long as ventral margin; the whole trapezoidal in shape. The second joint of peraeopod 7 with a shallow rounded posterior excavation. Pleon dorsally rounded with a low rounded medio-dorsal keel on segment 4; posteroinferior angle of segment 3 not produced, margin entire. Telson of adults of both sexes variable; typically triangular in the female (Fig. 3, P, Q) with the blunt, usually weakly notched apex produced beyond a pair of short spines, each of which bears a small lateral seta; telson in the male sometimes resembling that of the female but often broader and more rectangular with the terminal notch, if present, deeper and broader, the apex not produced beyond a pair of apical spines. A fine seta laterally placed to each of the spines may be present in either sex. Usually there are one or two pairs of narrow setae submarginally placed midway between apex and base of telson in both sexes.

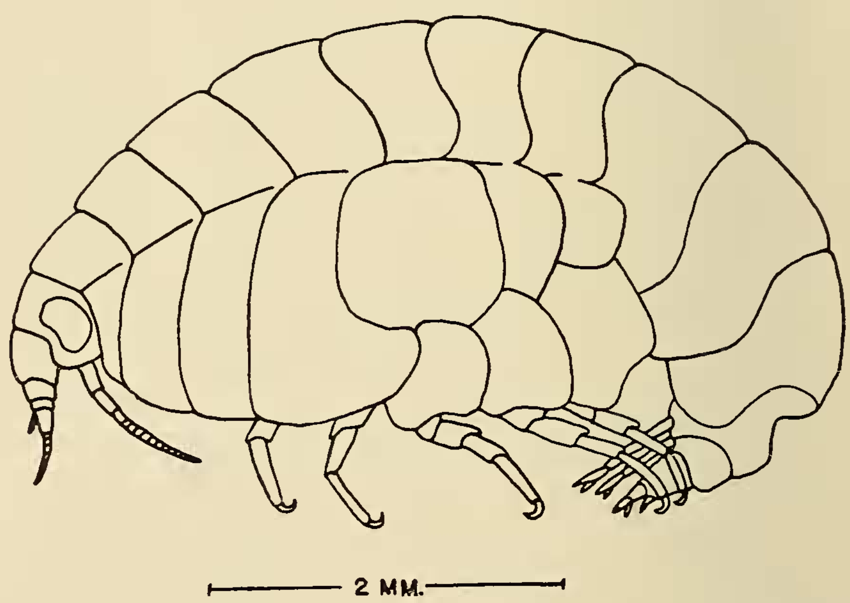

FIG. 1.—*Allogaussia recondita*. n. sp.: Mature male. For clarity, the pleopods are not shown.

Antenna I stout in both sexes, slightly longer in male (Fig. 2, A) than in female (Fig. 2, B), first joint very stout, medially flattened, lateral setae (Fig. 2, B) with fine long distal projections; second joint short; third joint visible from all sides, distal medial margin deeply emarginated in male exposing stout elongate first joint of flagel-

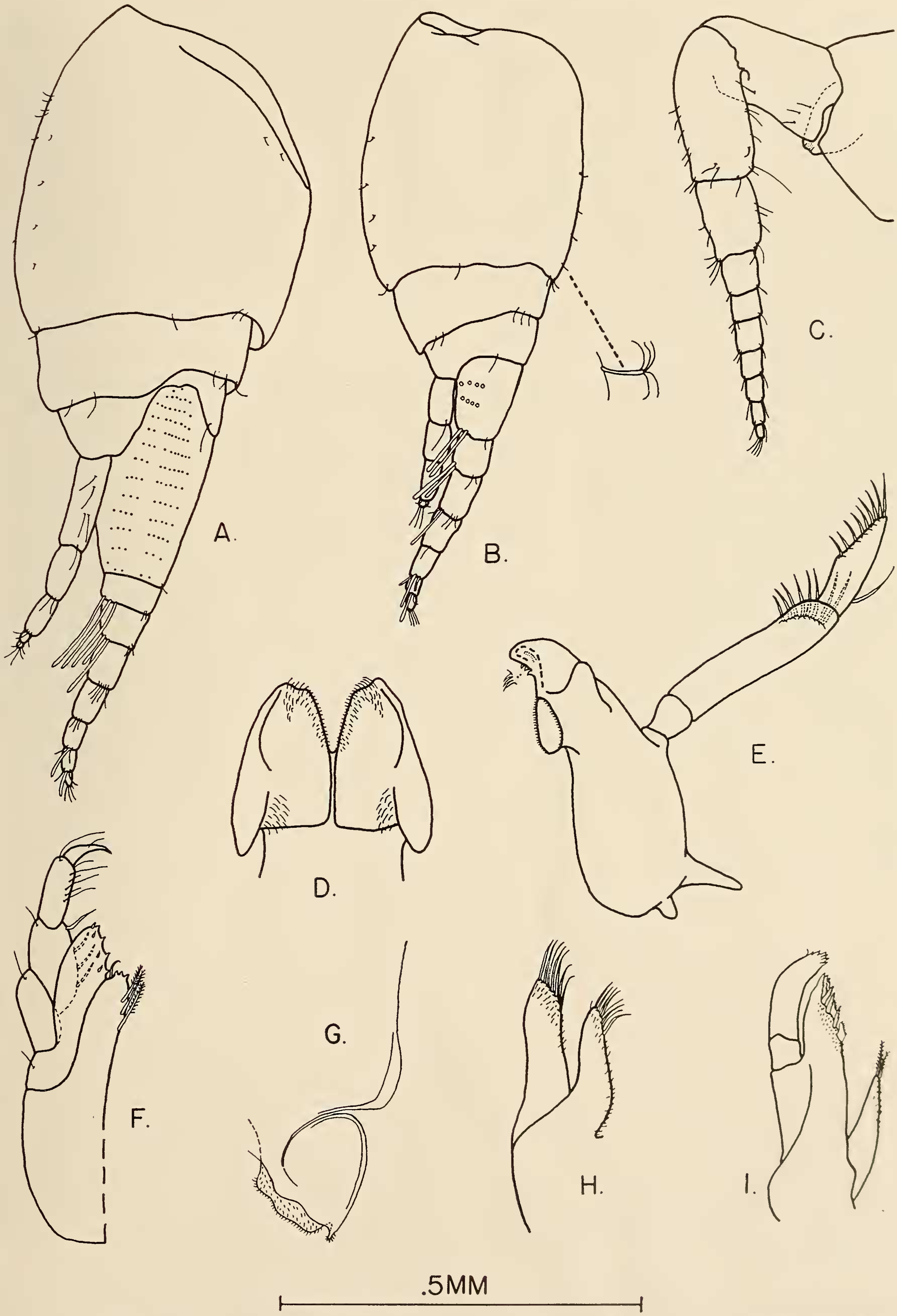

Fig. 2.—*Allogaussia recondita*, n. sp.: A, antenna I, male; B, antenna I, female, showing lateral seta enlarged; only origins of setae of first flagellar joint shown in both A and B; C, antenna II; D, lower lip; E, mandible, variation in length of spines of spine-row indicated; F, maxilliped; G, upper lip and epistome;, H maxilla II; I, maxilla I.

lum which bears two longitudinal groups of many heavy setae on medial surface; first flagellar joint in female not elongate, with few setae on medial surface. Flagellum of antenna I in male 8-jointed, rarely 9- or 10-jointed, in female usually 7-jointed though may be 6- or 8-jointed; accessory flagellum 4- rarely 5-jointed, first joint elongate in male, sparsely setose on ventromedial surface. Antenna II (Fig. 2, C) subequal in length to antenna I, with prominent gland cone; peduncle acutely flexed ventrally between joints 3 and 4, joint 4 the longest; flagellum slightly longer in male than in female, 8-10–jointed in male, 5-7–jointed in female.

Epistome (Fig. 2, G) produced in an arching manner over the rounded upper lip, the two separated by a deep, narrow sinus. Anterior margin of epistome sinuous. Mandible (Fig. 2, E) with rounded cutting edge and without terminal denticles, a single elongate blunt seta on the concave medial surface, spine row of three curved spines, molar well developed, finely denticulated, the denticles arranged in rows. Accessory plate between cutting edge and palp blunt. Palp as long as trunk, inserted just behind molar; second joint twice as long as third and with a row of setae on distal margin; third joint tapering distally and bearing a row of setae on distal margin, typically with a single long seta proximally placed on margin opposite from that bearing the row of setae. Lower lip (Fig. 2, D) with distal apices slightly excavated, lateral lobes only slightly divergent. Maxilla I (Fig. 2, I) with inner lobe tapering with two terminal plumose setae, outer lobe with 10 or 11 serrate spines, palp 2-jointed, the first joint short, the truncate apex of the second joint extending beyond outer lobe and bearing 5 or 6 stout setae and one fine marginal seta. Maxilla II (Fig. 2, H) with both lobes narrow, the inner lobe narrower than the outer and not quite as long; apices of both lobes setose on inner margins. Maxillipeds (Fig. 2, F) with inner lobe long with three stout terminal spines, one long terminal seta, and three plumose setae on inner margin; outer lobe extending to apex of second joint of palp, inner margin bearing a row of small nodulous teeth and a submarginal row of small setae; palp 4-jointed, fourth joint curved and acuminate.

Gnathopod I (Fig. 3, J) slightly chelate, second joint straight, setose on anterior margin, fifth with anterior margin twice as long as posterior margin, the distal posterior margin rounded, posterior margins of fourth and fifth joints finely setose, sixth joint only slightly longer than fifth, anterior and posterior margins parallel, palm convexly rounded with two spinules at distal posterior angle; dactylus slender, slightly overreaching palm. Gnathopod II (Fig. 3, K) minutely chelate, very slender, second joint slightly less than twice as long as third, fifth joint twice as long as sixth, sixth joint oblong with anterior margin rounded and bearing dense long setae; dactylus (Fig. 3, L) with one long seta on anterior margin and two blunt setae subterminally placed on posterior margin.

Uropod I longer than uropod II, outer ramus slightly longer than inner, rami of both I and II acuminate: uropod III shorter than others and relatively stouter, projects slightly beyond others posteriorly, inner ramus shorter than outer, outer ramus with a small second joint, inner margin of outer ramus nonsetose in female (Fig. 3, N), with 3-6 long plumose setae in male (Fig. 3, O).

Oostegites (Fig. 3, K) elongate, narrow, armed with 5 or 6 long distal setae. Branchiae simple on peraeopod 2 (= gnathopod II) and peraeopod 3, a single elongate distal accessory branchia on peraeopod 4 (Fig. 3, M), and a single proximal accessory branchia laterally placed on both peraeopods 5 and 6.

Color, pinkish or yellowish with minute irregular golden flecks scattered upon the body.

Length, 4–5 mm when at rest.

Types: The following have been deposited in the United States National Museum: (1) Holotype, 1 adult male, 4 mm. long, U.S.N.M. no. 99978; (2) paratypes, 6 males and 6 females, U.S.N.M. no. 99979.

Type locality, "Sand Rocks," Moss Beach, San Mateo County, Calif.

Range, unknown. Besides the type locality, this species has been found in *Anthopleura* at two locations near Bodega Bay, Sonoma County, Calif.; namely, the north jetty bordering the entrance to Bodega Harbor, and the rocks just east of Doran Beach.

Fig. 3.—*Allogaussia recondita*, n. sp.: J, Gnathopod I; K, gnathopod II and oostegite; L, enlarged dactylus of gnathopod II; M, side-plate 4 with attached branchia; N, uropod III, female; O, uropod III, male; P, telson, female; Q, telson enlarged; R, peraeopod 5; S, peraeopod 7.

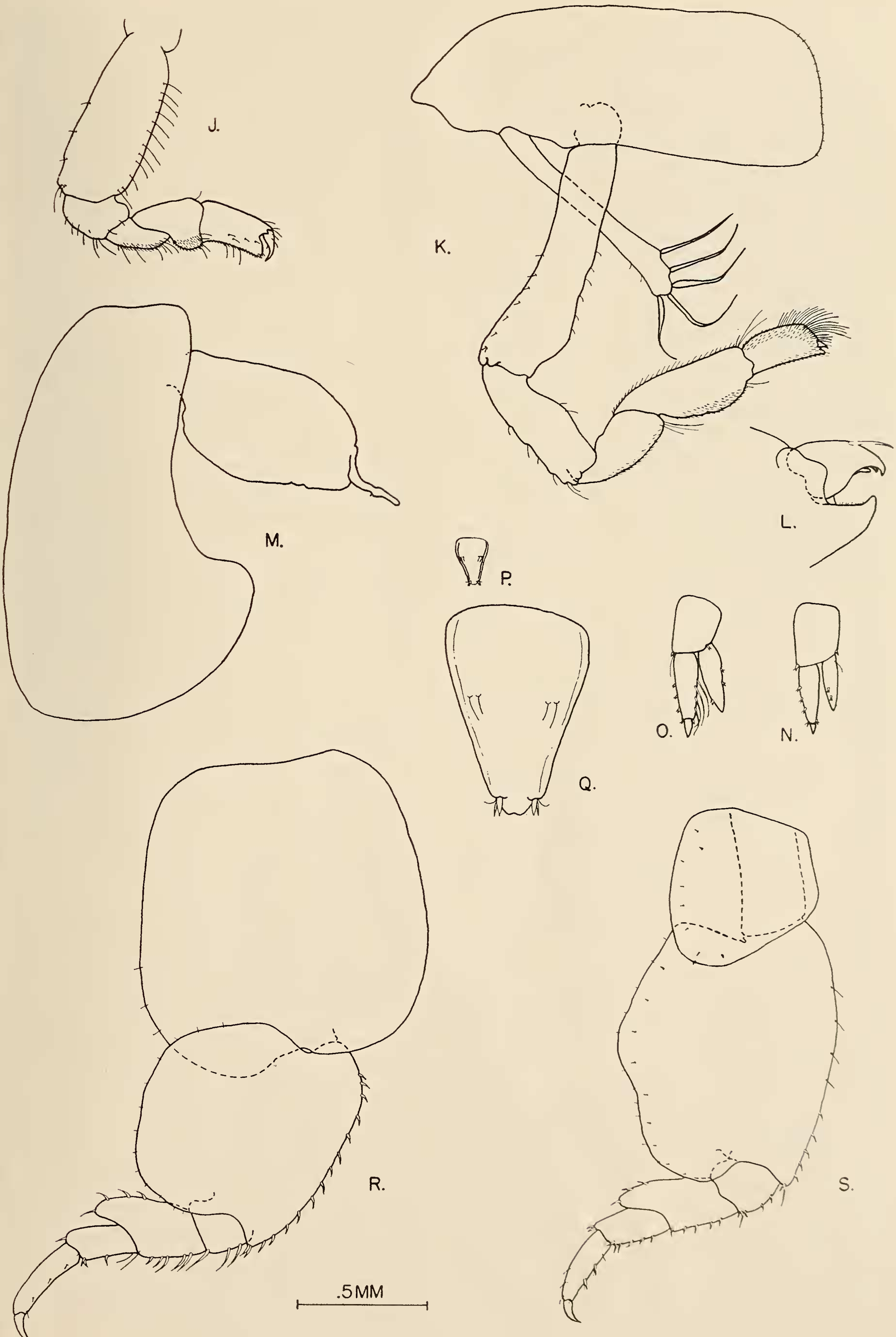

FIG. 3—(See opposite page for legend).

DISCUSSION

The genus *Allogaussia* is probably a heterogeneous one. It is Barnard's expansion of *Allogaussia* that makes it possible to include the present species in the genus. Schellenberg's original description would exclude it on the basis of uropod characters: the second projecting furthest in his species, the third in those of Barnard and in the species from *Anthopleura*; the third uropod not being setose in the males of Schellenberg's species, but being so in *Allogaussia recondita* and in those described by Barnard. The expansion of *Allogaussia* by inclusion of Barnard's species in the genus also affects the following generic characters: the relative size of the second peduncular joint of antenna I and the strange masked condition of the third peduncular joint of this appendage; also the degree of emargination of the telson whereby there is now a gamut from short and entire or slightly emarginate to long and slightly or deeply cleft representatives.

Barnard (1932, p. 64) makes the point that, "the 1st antenna [of his species] is entirely different [from those described by Schellenberg] and in conjunction with the character of the side plates almost makes a separate genus advisable." A new generic name was not proposed by Barnard, however, and the expanded concept of *Allogaussia* must stand, for the time at least.

The further expansion of the genus demanded by the inclusion of *Allogaussia recondita* within it serves to emphasize the probable heterogeneity of *Allogaussia*, and will, perhaps, lend impetus to a thorough analysis of this genus.

Many authorities have presented single numbers to indicate the number of joints in the flagella of antenna I and antenna II, and have used such numbers as specific characters (e.g. Barnard in describing *Allogaussia navicula*, p. 65). Such designations in the present species are not possible. Not only do the numbers of flagellar joints vary through ontogeny, but adults of the same sex and of comparable size display varying numbers of such joints. Even flagella from opposite sides of a single individual may present different numbers of joints. In the latter case, which is not uncommon, the difference is of one joint only. The detailed studies of Sexton (1924) on *Gammarus chevreuxi* and of Segerstrale (1937) on *Pontoporeia affinis* as well as the more recent works of Nayar (1956) on *Grandidierella bonnieri* and of Clemens (1950) on *Gammarus fasciatus* have shown that differences in numbers of antennal joints are related to degree of maturity; therefore, a range of values for these characters seems more logical than a single number and has been employed in the preceding description.

The character of the telson is likewise variable in the new species. The typical picture of the telson in the female is presented in the description (Plate 2, P, Q), but the lateral edges may be concave instead of nearly straight, thus the telson appears to bulge greatly towards the base. In some cases, egg-bearing females were seen to have emarginated telsons. In the male the degree of apical emargination varies from almost no excavation at all to a very broad, though shallow, concavity. Immature stages were not studied in detail, although it was noticed that telsons of individuals about ready to be released from the brood pouch bore a relatively deep emargination, and that immature individuals free of the parent's pouch presented deeper emarginations than the larger adults. The degree of emargination apparently decreases with age.

The occasional presence of supernumerary spines on the telson is a further variable feature of this species. One immature female was observed to have a single asymmetrically placed supernumerary spine on the terminal margin of the telson. The telson of a mature male bore two such supernumerary spines: one on either side of the median line. Of these, one was marginally placed while the other was submarginal in location. All observed supernumerary spines bore a lateral seta.

PRELIMINARY OBSERVATIONS ON THE ASSOCIATION OF A. RECONDITA AND ANTHOPLEURA ELEGANTISSIMA

The association of *Allogaussia recondita* and *Anthopleura elegantissima* remains to be studied in detail, but a few observations will be reported here. Amphipods were collected when the anemones were exposed at low tide. At these times no amphipods were found outside the anemones, but only within the gastrovascular tract among the gastric filaments which they resemble in color. Anywhere from three to 12 specimens were collected from each anemone. Inspections of neighboring *Anthopleura xanthogrammica*, a closely related species, did not reveal the presence of *Allogaussia*, and it was felt that this absence demonstrated some host specificity on the part of the amphipod. When anemones bearing amphipods were removed to the laboratory and placed in an aquarium of sea water, the amphipods crawled out through the stomodaeum and onto the oral disc as the anemones expanded. From there they wandered about the bases of the tentacles and even onto or over these structures, suffering no apparent harm. Occasionally a specimen could be seen on the column of an anemone. When forcibly pushed into the tentacular mass and then removed, it could be seen that the amphipod "stuck" to the tentacles, but that it was able to continue on its way apparently uninjured. One very small *Allogaussia* was seen to race rapidly up and down a tentacle without being impeded in any way. It is not clear just what sort of relationship this might be. Certainly the amphipods do not seem to irritate the anemone.

On one occasion a large *Anthopleura xanthogrammica* was placed in an aquarium with members of the smaller *A. elegantissima*, the latter containing amphipods. The following day amphipods were observed crawling about on the large anemone without hinderance! Whether or not this represents a lowering of specificity on the part of the amphipods because of the crowded condition of the aquarium remains to be determined.

Another feature of interest is the geographical and ecological distribution of the new species. Hand (1955, p. 60) gives the range of *Anthopleura elegantissima* as being from Alaska to Southern California. In the area of his study, from Bodega Head to Carmel, this species, "occurs as dense aggregations or as single individuals at all locations along the rocky open coast. It also penetrates deeply into bays, and in such situations large single individuals are more common than aggregations." With this in mind, it might be asked whether *Allogaussia* has a distribution similar to that of its host. An answer to this question cannot be given at present. That *Allogaussia recondita* does not occur in all areas where *Anthopleura elegantissima* thrives is evident from its very limited, almost "colonylike" distribution at Moss Beach. At this locality amphipods could be found only in those anemones on the "Sand Rocks," the numbers of specimens per anemone becoming less as the distance from these rocks increased, until, finally, no amphipods at all could be found in *Anthopleura*. Such a condition may be seasonal, may vary from year to year, or it may represent specific ecological factors not evident at this time.

Surprisingly enough, the association here described is not unique. In 1925, Elmhirst briefly described a similar relationship in England between the gammarid *Metopa solsbergi* and the anemone *Actinoloba dianthus* (now *Metridium senile*). The anemones of this association were found living on pilings 12 or 15 feet below low water. The amphipods were seen to move about over the surface of the anemone and to enter and leave the stomodaeum unharmed. "*Tealia crassicornis* ate them without hesitation, *Actinia equina* took them slowly, but after some minutes the *Metopa* generally emerged again" (Elmhirst, 1925, p. 150). Elmhirst mentions that the slime of *Actinoloba* seems to be the natural food of the amphipod.

Edmondson (1951) described *Elasmopus calliactis* which lives in association with an anemone, *Calliactus armillatas*, taken from depths of about 16 fathoms off the coast of Oahu in the Hawaiian Islands. The anemone is found upon shells inhabited by a hermit crab and Edmondson states (p. 189) that "While its usual host is the sea anemone, the amphipod harmonizes in color equally well with the hermit crab and no doubt has freedom of movement from one organism to the other." Nothing about the association more definite than this was noted. How much similarity exists between these associations and that of *Anthopleura-Allogaussia* is not known.

The species here described is the first of the genus to be discovered in the Pacific. The species of Schellenberg and of Barnard are described from antarctic waters or from the waters off South Georgia Island in the South Atlantic. Moreover, the new species is the first to be found in the littoral zone. All previous species were brought up from deep water in dredges or trawls.

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The ultimate aim of those who are devoted to science is to penetrate beyond the phenomena observed on the surface to the ultimate causes, and to reduce the whole . . . to a simple deductive system of mechanics, in which the phenomena observed shall be shown to flow naturally from the few simple laws that underlie the structure of the universe.—Cleveland Abbe.